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*F. Kueffner*

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09/05/01

ASSISTANT COMMISSIONER FOR PATENTS  
Washington, DC 20231

Date: **August 30, 2000**

Docket No: **BO-107**

Sir:

Transmitted herewith for filing is the patent application of:

Inventor(s): **Wolfgang Streubel and Wigbert Christophliemke**

FOR **METHOD OF MANUFACTURING A BENDING-RESISTANT, TORSIONALLY YIELDING TUBULAR PROFILED MEMBER AS A TRANSVERSE SUPPORT FOR A TWIST BEAM REAR AXLE OF A PASSENGER CAR**

**ENCLOSED ARE:**

- (X) Specification (12 pages), Claims (4 pages/13 claims) & Abstract;
- (X) one (1) sheet of Drawing; (Figs. 1 - 5)
- (X) Declaration and Power of Attorney; **UNSIGNED**
- ( ) Assignment to Benteler AG;
- ( ) Certified copy of GermanPatAppliNo. 199 41 993.0 filed September 2, 1999 the priority of which is claimed under 35 USC 119;
- ( ) Verified Statement to establish Small Entity Status (37 CFR 1.9 & 1.27);
- ( ) Information Disclosure Statement, PTO-1449 and      references;

**THE FILING FEE HAS BEEN CALCULATED AS SHOWN BELOW:**

	Claims filed	Extra	SMALL ENTITY	or	LARGE ENTITY
Basic Fee			\$ 345.00		\$ 690.00
Total Claims	13	-20=	x \$ 9.=	x	\$ 18.=
Indep. Claims	2	- 3=	x \$ 39.=	x	\$ 78.=
( ) Multiple Dependent Claim Presented?			x \$130.=	x	\$260.=

Respectfully submitted

*F. Kueffner*

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FK:ml

**APPLICATION FOR UNITED STATES LETTERS PATENT**

**METHOD OF MANUFACTURING A BENDING-RESISTANT,  
TORSIONALLY YIELDING TUBULAR PROFILED MEMBER AS A  
TRANSVERSE SUPPORT FOR A TWIST BEAM REAR AXLE OF A  
PASSENGER CAR**

## **BACKGROUND OF THE INVENTION**

### **1. Field of the Invention**

The invention relates to a method of manufacturing a bending-resistant, torsionally yielding tubular profiled member as a transverse support for a twist beam rear axle of a passenger car.

### **2. Description of the Related Art**

Various suggestions are known in regard to designs of transverse supports of a twist beam rear axle of a passenger car in order to provide them, on the one hand, with bending resistance and, on the other hand, with a sufficient torsional yield. Prior art references concerned with these problems are, for example, EP 0 249 537 B1, EP 0 681 932 A2, EP 0 752 332 B1, DE-Gm 297 20 207, and U.S. 2,069,911.

All of these transverse supports have in common that their manufacture overall is complex, and, accordingly, the production costs within the context of a complete twist beam rear axle are high.

## SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method of manufacturing a bending-resistant, torsional yielding tubular profiled member as a transverse support for a twist beam rear axle for a passenger car which not only ensures an increased economical production but also, with respect to the respectively required conditions, makes it possible to design the individual process parameters variable as much as possible.

In accordance with the present invention, this is achieved according to a first variant of the method in that a tubular blank of tempering steel is first provided by U-shaped cold forming with a torsionally yielding central longitudinal section while ensuring torsion-proof end sections, whereupon the thus formed tubular profiled member is annealed at least in partial sections thereof at a temperature level between 850° C and 960° C, is subsequently hardened in water at a temperature above the AC3 point, is subsequently tempered at a temperature between 200° C and 550° C for a duration of more than 5 minutes, is subsequently subjected to at least an outer surface hardening, and is finally subjected to further configuration processing steps for completing a twist beam rear axle.

Accordingly, a tube blank, independent of its cross-section, of tempering steel is being used for the manufacture of a tubular profiled member as a transverse support for a twist beam rear axle. First, the tube blank is provided by means of U-shaped cold forming with a central longitudinal section that is torsionally yielding while ensuring at the same time torsion-proof end section. The configuration of the end sections can be as desired. It can be circular or shoe-shaped, optionally with incorporation of stay-shaped sheet metal. Also, reinforcement embossments can be provided in the transitional sections between the U-shaped central longitudinal section and the end sections.

After cold forming, the now present tubular profiled member is subjected to a heat treatment in which, at least in partial sections thereof, it is annealed at a temperature level between 850°C and 960°C. In this context, the term partial sections refers preferably to the end sections of the tubular profiled member. Subsequently, the tubular profiled member is hardened in water at a temperature above the AC3 point of the iron-carbon-diagram and is subsequently tempered at a temperature between 200° C and 550° C for a duration of more than 5 minutes.

A tubular profiled member formed and heat-treated such

exhibits then a high permanent strength under dynamic load, as is desirable especially in regard to the aforementioned torsional profiled member as a component of the twist beam rear axle of a passenger vehicle.

Subsequent to the heat treatment, the tubular profiled member is subjected to at least an outer surface hardening. This refers primarily to a mechanical surface hardening. Optionally, it is also possible to perform an additional inner surface hardening, especially by mechanical means.

Finally, the thus manufactured tubular profiled member is subjected to further configuration processing steps for completion of a twist beam rear axle.

An especially advantageous embodiment of the afore described variant is provided when the tubular profiled member is annealed at a temperature level between 920°C and 950° C, especially approximately 930° C.

In this context it is especially important when the annealed tubular profile is then tempered at a temperature of approximately 280° C for a duration of approximately 20 minutes.

In the context of the invention it is also advantageous when a tube blank of the material specification 22MnB5 is used for the manufacture of the tubular profiled member as a transverse support of a twist beam rear axle.

In accordance with the present invention, the object of the invention is moreover achieved according to a second variant of the method in that a tubular blank of case-hardening steel is first provided by U-shaped cold forming with a torsionally yielding central longitudinal section while ensuring torsion-proof end sections, whereupon the thus formed tubular profiled member is subjected to case hardening at least in partial sections thereof during the course of a heat treatment by carburization of the surface layer of the tubular profiled member with subsequent quenching, is subsequently subjected to at least an outer surface hardening process, and is finally subjected to further configuration processing steps for completion of a twist beam rear axle.

In the context of this variant a case-hardening steel is used. In this variant, a tube blank of a case-hardening steel is also first provided by U-shaped cold forming with a torsionally yielding central longitudinal section. The end sections of the tubular profiled member are, however,

torsion-proof. As in the first variant, the end sections can be of different configurations.

Subsequent to the cold forming step, the thus formed tubular profiled member is case-hardened at least in partial sections thereof during the course of a heat treatment by carburization of the surface layer of the tubular profiled member with subsequent quenching. According to the invention, this also ensures that a cold-formed tubular profiled member as a transverse support in the context of a finished twist beam rear axle is provided with a high permanent strength under dynamic load.

After the heat treatment process an outer surface hardening is carried out. Subsequently, the tubular profiled member is subjected to further configuration processing steps for completion of a twist beam rear axle.

A preferred steel specification (quality) for forming a bending-resistant, torsionally yielding tubular profiled member is C15.

For the first as well as for the second variant of the method according to the invention, it is very advantageous when the heat treatment of the cold-formed tubular profiled





## BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

Fig. 1 is a plan view of a tubular profiled member as a transverse support for a twist beam rear axle of a passenger car;

Fig. 2 is a cross-section of the tubular profiled member according to Fig. 1 along the section line II-II;

Fig. 3 is a cross-section of the tubular profiled member according to Fig. 1 along the section line III-III;

Fig. 4 is a cross-section of the tubular profiled member according to Fig. 1 along the section line IV-IV; and

Fig. 5 is a cross-section of the tubular profiled member according to Fig. 1 along the section line V-V.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

In Fig. 1 a tubular profiled member 1 as a transverse support for a twist beam rear axle (known in the art and therefore not explained in more detail in this context) of a passenger car is illustrated. The tubular profiled member 1 is manufactured of an originally round tube blank (Fig. 5) which is comprised of a tempering steel of the steel specification 22MnB5.

The non-cutting cold forming step maintains the cross-section of the tubular profiled member 1 in the end sections. This circular cross-section of the ends 2 of the end sections a of the tubular profiled member 1 has, however, a continuous transition via the transition sections b into a U-shaped double-wall cross-section which extends across the central longitudinal section c of the tubular profiled member 1 (Figs. 1 through 5).

Assuming that the tubular profiled member 1 according to Fig. 1 is illustrated in a plan view, i.e., in the mounted position within the passenger car, the legs 3 of the central U-shaped longitudinal section c (Figs. 2 and 3) extend from an arc-shaped stay 4 in the direction of travel FR with slight divergence relative to the horizontal central

longitudinal plane MLE of the tubular profiled member 1 extending through the longitudinal axis LA.

The tubular profiled member 1 is provided with groove-like embossments 5 at the ends of the central U-shaped longitudinal section c. These embossments 5 extend in a direction transverse to the tubular profiled member 1. Fig. 3 shows that the embossments 5 have the greatest depth at the apex S of the U-shaped longitudinal section c located in the horizontal central longitudinal plane MLE. The depth of the embossments decreases in the direction toward the free ends 6 of the legs 3 until they uniformly adjoin the outer surface 7 of the legs 3. Viewed in longitudinal section, the embossments 5 thus have a sickle-shaped configuration.

The edges 9 of the embossments 5 are rounded.

After cold forming of a circular tube blank of tempering steel of the steel specification (quality) 22MnB5 the now present tubular profiled member 1 according to Figs. 1 through 5 is annealed in the transition sections b at a temperature level of approximately 930° C. Subsequently, the tubular profiled member 1 is hardened in water at a temperature above the AC3 point and is subsequently tempered at a temperature of approximately 280° C for a duration of

20 minutes. Then the tubular profiled member 1 is bombarded with steel balls on its outer surface 10 and is subsequently subjected to further configuration processing steps for completion of a twist beam rear axle.

While specific embodiments of the invention have been shown and described in detail to illustrate the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A method of manufacturing a bending-resistant, torsionally yielding tubular profiled member as a transverse support of a twist beam rear axle of a passenger car, the method comprising the steps of:

cold-forming a tube blank of tempering steel to a tubular profiled member with a torsionally yielding central longitudinal section of a U-shaped cross-section and with opposed torsion-proof end sections;

annealing at least partial sections of the tubular profiled member at a temperature level between 850° C and 960° C;

hardening the tubular profiled member in water at a temperature above the AC3 point;

tempering the tubular profiled member at a temperature between 200° C and 550° C for a duration of more than five minutes;

subjecting the tubular profiled member at least to an outer surface hardening process; and

subjecting the tubular profiled member to further configuration processing steps for completing a twist beam rear axle.

2. The method according to claim 1, wherein the step

of annealing is carried out at a temperature level between 920° C and 950° C.

3. The method according to claim 2, wherein the step of annealing is carried out at a temperature level of approximately 930° C.

4. The method according to claim 1, wherein the step of tempering is carried out at a temperature of approximately 280° C for a duration of approximately 20 minutes.

5. The method according to claim 1, wherein the tempering steel of the tube blank is of the specification 22MnB5.

6. The method according to claim 1, wherein the outer surface hardening is carried out by bombardment with balls.

7. The method according to claim 6, wherein the surface hardening is carried out by bombardment with steel balls.

8. The method according to claim 1, wherein the step

of annealing is performed on transitional sections of the tubular profiled member located between the central longitudinal section and the end sections.

9. A method of manufacturing a bending-resistant, torsionally yielding tubular profiled member as a transverse support of a twist beam rear axle of a passenger car, the method comprising the steps of:

cold-forming a tube blank of case hardening steel to a tubular profiled member with a torsionally yielding central longitudinal section of a U-shaped cross-section and opposed torsion-proof end sections;

case-hardening at least partial sections of the tubular profiled member during a heat treatment with carburization of the surface of the tubular profiled member and subsequent quenching;

subjecting the tubular profiled member at least to an outer surface hardening process; and

subjecting the tubular profiled member to further configuration processing steps for completing a twist beam rear axle.

10. The method according to claim 9, wherein the case-hardening steel of the tube blank is of the specification C15.



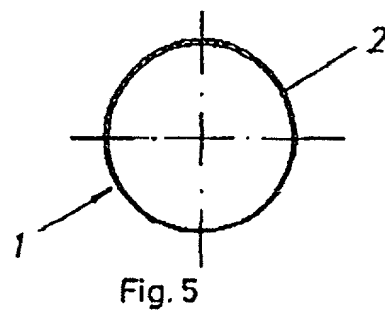
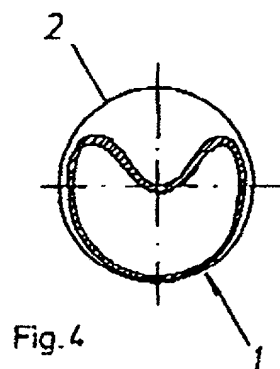
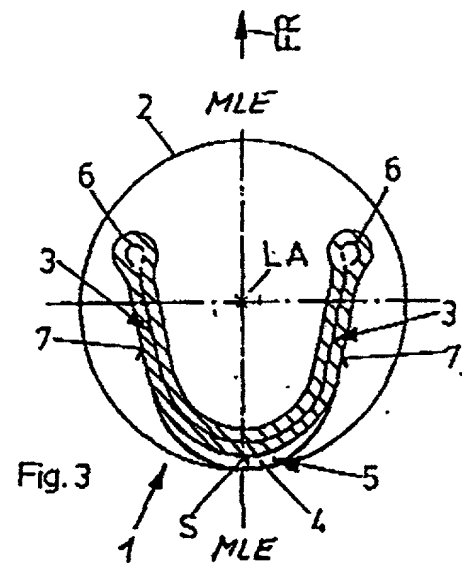
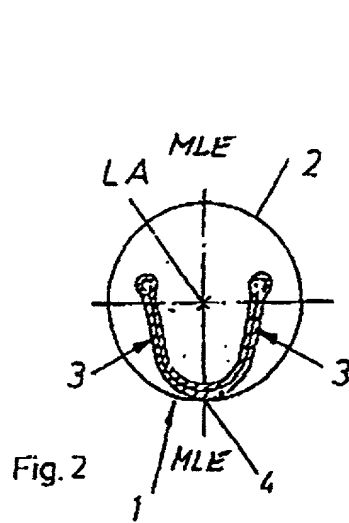
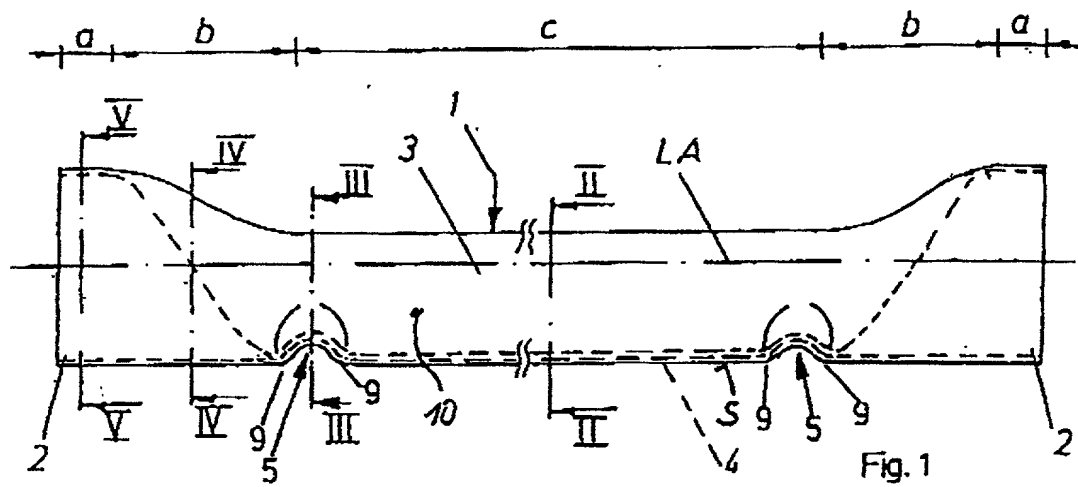
11. The method according to claim 9, wherein the step of case-hardening is performed on transitional sections of the tubular profiled member located between the central longitudinal section and the end sections.

12. The method according to claim 9, wherein the surface hardening is carried out by bombardment with balls.

13. The method according to claim 12, wherein the surface hardening is carried out by bombardment with steel balls.

## ABSTRACT OF THE DISCLOSURE

In a method of manufacturing a bending-resistant, torsionally yielding tubular profiled member as a transverse support of a twist beam rear axle of a passenger car, a tube blank of tempering steel is cold formed to a tubular profiled member with a torsionally yielding central longitudinal section of a U-shaped cross-section and with opposed torsion-proof end sections. At least partial sections of the tubular profiled member are annealed at a temperature level between 850° C and 960°C. The tubular profiled member is then hardened in water at a temperature above the AC3 point and subsequently tempered at a temperature between 200° C and 550° C for a duration of more than five minutes. As an alternative, a tube blank of case hardening steel is used, and at least partial sections of the tubular profiled member formed from this tube blank are case-hardened during a heat treatment with carburization of the surface of the tubular profiled member and subsequent quenching. The tubular profiled member in both variants is then subjected to at least one outer surface hardening process and finally subjected to further configuration processing steps for completing a twist beam rear axle.



**Declaration and Power of Attorney for Patent Application**  
**Erklärung für Patentanmeldungen mit Vollmacht**  
**German Language Declaration**

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

daß ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

**VERFAHREN ZUR HERSTELLUNG EINES BIEGESTEIFEN TORSIONSWEICHEN ROHRPROFILS LS QUERTRÄGER FÜR EINE VERBUNDLENKERHINTERACHSE EINES PERSONENKRAFTWAGENS**

deren Beschreibung  
(Zutreffendes ankreuzen)

☒ hier beigefügt ist.

☐ am \_\_\_\_\_ unter der  
Anmeldungsseriennummer \_\_\_\_\_  
eingereicht wurde und am \_\_\_\_\_  
abgeändert  
wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, daß ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag, wie oben erwähnt, abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Patentierbarkeit in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder ein Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**METHOD OF MANUFACTURING A BENDING-RESISTANT, TORSIONALLY YIELDING TUBULAR PROFILED MEMBER AS A TRANSVERSE SUPPORT FOR A TWIST BEAM REAR AXLE OF A PASSENGER CAR**

the specification of which (check one)

☒ is attached hereto

☐ was filed on Application Serial No. \_\_\_\_\_  
and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

## Erklärung mit Völlmacht (auf Deutsch)

## Declaration and Power of Attorney (in English)

<u>199 41 993.0</u>	<u>Germany/Deutschland</u>	<u>September 2, 1999/2. September 1999</u>	<u>X</u>	
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Nummer)	(Land)	(Tag/Monat/Jahr eingereicht)	Ja	Nein
<u>                    </u>	<u>                    </u>	<u>                    </u>	<u>Yes</u>	<u>No</u>
(Number)	(Country)	(Day/Month/Year Filed)	Ja	Nein
(Nummer)	(Land)	(Tag/Monat/Jahr eingereicht)		
<u>                    </u>	<u>                    </u>	<u>                    </u>	<u>Yes</u>	<u>No</u>
(Number)	(Country)	(Day/Month/Year Filed)	Ja	Nein
(Nummer)	(Land)	(Tag/Monat/Jahr eingereicht)		

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 112, offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder internationalen Anmeldedatum dieser Anmeldung bekannt sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or international filing date of this application.

<u>(Application Serial No.)</u>	<u>(Filing Date)</u>	<u>(Status/ patentiert</u>	<u>(Status/ patented,</u>
<u>(Anmeldeseriennummer)</u>	<u>(Anmeldedatum)</u>	<u>anhangig, aufgegeben)</u>	<u>pending, abandoned)</u>
<u>(Application Serial No.)</u>	<u>(Filing Date)</u>	<u>(Status/ patentiert</u>	<u>(Status/ patented,</u>
<u>(Anmeldeseriennummer)</u>	<u>(Anmeldedatum)</u>	<u>anhangig, aufgegeben)</u>	<u>pending, abandoned)</u>

Ich erkläre hiermit, daß alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und daß ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, daß wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden können, und daß derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Docket No. BO-107

**Erklärung mit Völlmacht (auf Deutsch)**

**Declaration and Power of Attorney (in English)**

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäft vor dem Patent-und Warenzeichenamt:

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

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FRIEDRICH KUEFFNER, Reg. No. 29,482

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Full name of first or sole inventor:

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Unterschrift des Erfinders

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<p>Unterschrift des Erfinders _____ Datum _____</p>	<p>Inventor's Signature _____ Date _____</p>
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<p><u>Deutschland</u> Staatsangehörigkeit</p>	<p><u>Germany</u> Citizenship</p>
<p><u>Am Lauderbach 113</u></p>	<p><u>Am Lauderbach 113</u></p>
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